Homework Calculations Report

This report describes the calculations and reasoning leading to my final answers

Assumptions

- 90% of a given program can be perfectly parrallelized, the other 10% remains sequential
- We have a fixed power budget
- Total power is proportional to the square of frequency
- Performance is proportional to frequency
- The programs performance on a single-core chip is 1 solutions per seconds

Task 1: Calculate performance on a dual-core chip

On a single-core system, with the frequency f_1, has the power usage of $P = cf_1^2$. Since the total power is fixed, the two dual-chip cores must share this power between them. We can therefore calculate the frequency f_2 for each of the cores:

$$\frac{P}{2} = cf_2^2$$

$$\frac{cf_1^2}{2} = cf_2^2$$

$$\frac{f_1}{\sqrt{2}} = f_2$$

Assuming that on the sequential sections of the program, only one core is working, we can therefore calculate the performance for the throughput for the parallelizable and sequential sections of the program

$$t_p = 2 * f_2 = 2 * \frac{f_1}{\sqrt{2}} = \sqrt{2} * f_1 = \sqrt{2}\, solutions/s$$

$$t_s = 1 * f_2 = \frac{f_1}{\sqrt{2}} = \frac{1}{\sqrt{2}}\, solutions/s$$

We can now calculate the total troughput, and therefore performance, of the program on the dual-core chip

$$t_{total} = 0.9 * t_p + 0.1 * t_s$$

$$t_{total} = 0.9 * \sqrt{2}\, solutions/s + 0.1 * \frac{1}{\sqrt{2}} solutions/s$$

$$t_{total} = \frac{19\sqrt{2}}{20}\, solutions/s$$

$$t_{total} \approx 1{,}344\, solutions/s$$

Task 2: Calculate performance on a quad-core chip

As before, we can calculate the frequency f_4 for each of the four cores:

$$\frac{P}{4} = cf_4^2$$

$$\frac{cf_1^2}{4} = cf_4^2$$

$$\frac{f_1}{\sqrt{4}} = f_4$$

$$\frac{f_1}{2} = f_4$$

Again, we calculate the performance for the throughput for the parallelizable and sequential sections of the program

$$t_p = 4 * f_4 = 4 * \frac{f_1}{2} = 2f_1 = 2\ solutions/s$$

$$t_s = 1 * f_4 = \frac{f_1}{2} = \frac{1}{2}\ solutions/s$$

We now calculate the total throughput

$$t_{total} = 0.9 * t_p + 0.1 * t_s$$

$$t_{total} = 0.9 * 2\ solutions/s + 0.1 * \frac{1}{2} solutions/s$$

$$t_{total} = 1{,}85\ solutions/s$$